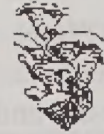


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Evaluation of verbenone treatments for the prevention of mountain pine beetle (*Dendroctonus ponderosae*) attacks on lodgepole pine at Lookout Pass Ski and Recreation Area 2003-2008

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EXECUTIVE SUMMARY

The forests in and around Lookout Pass Ski and Recreation Area have a significant component of lodgepole pine (*Pinus contorta*) susceptible to mountain pine beetle (*Dendroctonus ponderosae*)(MPB) attack. Aerial Detection Surveys (ADS) began to detect lodgepole pine mortality attributed to MPB in the vicinity of the recreation area in the mid 1990s.

In 2008, the sixth and final annual application of verbenone, the anti-aggregation pheromone for MPB, was made to forested strips between ski runs at Lookout Pass Ski and Recreation Area to protect susceptible lodgepole pine trees from MPB attack. From 2003-2006, two applications of Pherotech Inc.'s 5-gram verbenone pouch were made. The first application was made in late May, early June and the second application was made in mid-July. In 2007, Beetle Block Verbenone 7-gram pouch produced by Synergy Semiochemical Corporation was the only EPA registered verbenone product available. One

application of 20 Beetle Block Verbenone pouches per acre was made in early June. In 2008, one application of Pherotech Inc.'s 7-gram verbenone pouch was made in early June.

During the June 2008 verbenone application, a number of 2007 MPB attacks were found in treated forested strips. Many of the attacks appeared to have occurred after the time of the 2007 verbenone treatment evaluation in October, 2007. MPB in north Idaho typically fly in July.

Because of the volume of observed MPB mortality in 2008, no verbenone was applied in 2009 to high priority forested strips.

Long term solutions to the bark beetle mortality at Lookout Pass Ski and Recreation area will require silvicultural prescriptions which address the underlying stand susceptibility to MPB. More immediate action may be required to address the number of MPB killed lodgepole pine trees adjacent to ski runs. These dead trees may pose a risk to skiers in the future.

INTRODUCTION

Lookout Pass Ski and Recreation Area operates under a Forest Service special use authorization administered by the Idaho Panhandle National Forests (IPNF). Located on the border of the IPNF and Lolo National Forests, the recreation area has provided winter recreation opportunities for over 70 years. Currently, the forests in and around the recreation area have a significant component of lodgepole pine which is being attacked by mountain pine beetle (*Dendroctonus ponderosae*) (MPB). MPB may attack and kill many of the larger diameter lodgepole pine trees in forested buffer strips between designated ski runs during the course of the current outbreak.

In order to protect the lodgepole pine in forested strips between existing ski runs, the IPNF requested Forest Health Protection (FHP) technical and financial assistance. FHP has provided technical assistance (Appendix 1) and suppression funding (Appendix 2) annually since 2003 to treat from 40 (2003) to 130 (2008) acres of forested strips having large-diameter

lodgepole pine with verbenone, the anti-aggregation pheromone for MPB. The IPNF also conducted an extensive survey of forested strips on the existing ski hill, and on forested strips between new runs that were created in the summers of 2003 and 2005. From 2003-2008 FHP has invested \$161,423 in support of verbenone treatments at Lookout Pass Ski and Recreation area.

This report summarizes information on the 2003-2008 verbenone application and a post treatment evaluation of 2008 treated units. Verbenone treatment ended in 2008.

TREATMENT HISTORY

Applications of verbenone began on the ski hill in 2003, when 40 acres of susceptible forested strips were treated. The treatment area was expanded in 2004 to cover 100 acres, 120 acres in 2005, 126 acres in 2006, and 130 acres in 2007 and 2008 (Table 1, Table 3, Figure 1).

TABLE 1: Verbenone treatment history for forested strips on Lookout Pass Ski and Recreation Area (Figure 1).

Area	Treatment						Area	Treatment					
	2008	2007	2006	2005	2004	2003		2008	2007	2006	2005	2004	2003
A&B	Yes	Yes	Yes	No	No	Yes	O	Some	No	No	Yes	No	No
C	Yes	Yes	Yes	Yes	Yes	Yes	P	Yes	Yes	Yes	Yes	No	No
D	No	No	No	No	No	Yes	AA	Yes	Yes	Yes	Yes	Yes	No
E	Yes	Yes	Yes	No	No	Yes	BB	Yes	Yes	Yes	Yes	Yes	No
F	No	No	No	No	No	Yes	CC	Yes	Yes	Yes	Yes	Yes	No
G	No	No	No	No	No	Yes	DD	Yes	Yes	Yes	Yes	Yes	No
H	Yes	Yes	Yes	No	No	Yes	EE	Yes	Yes	Yes	Yes	Yes	No
I&J	Yes	Yes	Yes	Yes	Yes	Yes	FF	Yes	Yes	Yes	Yes	Yes	No
K	Yes	Yes	Yes	Yes	Yes	Yes	GG	No	No	No	No	No	No
L	Yes	Yes	Yes	Yes	Yes	Yes	HH	Yes	Yes	Yes	Yes	Yes	No
M	Yes	Yes	Yes	Yes	Yes	Yes	II	Yes	Yes	Yes	Yes	Yes	No
N	Yes	Yes	Yes	Yes	Yes	No	2007 and 2008-Additional 8 acres treated below Skiway, M, & N						

FIGURE 1: Lookout Pass Ski and Recreation Area Ski Hill Schematic. Yellow letters refer to treatment polygons in forested leave strips between established runs.



2008 TREATMENT

In 2008 we used the 7-gram verbenone pouch produced by Pherotech, Inc. The 7-gram pouch is designed to last the entire flight period of the mountain pine beetle. No second application of verbenone is recommended by the manufacturer when using the 7-gram pouch. We stapled 20 7-gram verbenone pouches per acre to trees on a 15 meter grid.

As we applied the verbenone in June of 2008, we noted many green 2007 MPB attacked trees, which would change to red that fall. Many of these trees had not been detected during the 2007

evaluation. MPB in lodgepole pine typically has peak flight in July.

2008 RESULTS

In June 2009, FHP personnel evaluated all 19 verbenone treatment areas and one untreated area at Lookout Pass using the Forest Insect and Disease Tally System (FINDITS). Between two and 15 variable radius plots using a basal area factor (BAF) of 10 were randomly placed within treatment polygons. Diameter at breast height (DBH), species, and MPB activity (current attack, last year's attack, older attacks,

unattacked) were recorded for each tree in the plot. Data was then summarized using the FINDITS program (Bentz 2000).

FINDITS survey results for 2008, 2007, and older mountain pine beetle attacks are summarized in Table 2 for evaluated polygons. Treatment efficacy in 2008 was highly variable. In some of the treatment units no 2008 MPB losses were recorded (E, F, H, AA, CC, and DD). In other units, results were more mixed with 2008 MPB mortality greater than, less than, or about equal to 2007 levels (Table 2).

It is not possible to determine why results were variable. In many of the units experiencing MPB mortality, MPB infested trees were present prior to 2008 treatments (the trees were attacked

in 2007 and MPB brood were completing development as verbenone was being applied in spring 2008). Many researchers feel that if currently infested trees are present in a treatment area, the beetle produced aggregation pheromones will overpower manmade sources of anti-aggregation pheromone.

Variable treatment results may also be a result of the change in the formulation of verbenone and application methods. In past years we made two applications of 5-gram pouches, one in late May/early June and a second in early to mid-July. With the 7-gram pouches we only applied once in early June. It is possible that the pouches stopped releasing verbenone before the end of MPB flight, allowing MPB to make successful late season attacks.

TABLE 2: FINDITS survey results for verbenone treated polygons on Lookout Pass Ski and Recreation area, 2008. Grey shaded rows represent unit with 2008 MPB attacks.

Polygon (# plots)	Treatment History				2008 MPB Attacks TPA*	2007 MPB Attacks TPA*	Older MPB Attacks TPA*	Total Recorded MPB TPA*
	2008	2007	2006	2005				
A&B (8)	Yes	Yes	Yes	No	2.96	4.78	30.76	38.5
C (2)	Yes	Yes	Yes	Yes	16.54	0	0	16.54
E (2)	Yes	Yes	Yes	No	0	0	0	0
F(2)	No	No	No	No	0	0	0	0
H (2)	Yes	Yes	Yes	No	0	0	5.34	5.34
I&J (5)	Yes	Yes	Yes	Yes	12.27	19.08	13.48	44.83
K(2)	Yes	Yes	Yes	Yes	46.40	0	8.32	54.72
L(3)	Yes	Yes	Yes	Yes	3.97	30.20	0	33.97
M(10)	Yes	Yes	Yes	Yes	18.39	23.45	6.24	29.69
N&O (15)	Yes	Yes	Yes	Yes	10.45	6.74	46.28	63.47
P(10)	Yes	Yes	Yes	Yes	2.48	0	26.75	29.23
AA(3)	Yes	Yes	Yes	Yes	0	0	0	0
BB(4)	Yes	Yes	Yes	Yes	11.46	0	17.19	28.65
CC(4)	Yes	Yes	Yes	Yes	0	0	0	0
DD(5)	Yes	Yes	Yes	Yes	0	0	4.74	4.74
EE(10)	Yes	Yes	Yes	Yes	3.24	0	1.10	4.34
FF(10)	Yes	Yes	Yes	Yes	14.93	15.89	5.20	36.02
Below Skiway (8)	Yes	Yes	No	No	2.0	0	72.95	74.95

*TPA = Trees Per Acre

CURRENT STAND CONDITIONS

FINDITS stand information from the 2009 evaluation is summarized in Table 3. Though land managers have applied verbenone for six years, MPB remains active on the ski hill and a number of the treatment polygons remain at high

hazard for additional MPB losses. The only way to affect the susceptibility of the ski and recreation area to MPB and reduce the hazard rating is to address the quantity and quality of lodgepole pine available to beetles (Randall & Tensmeyer 2000, Appendix 3).

TABLE 3: 2009 Lookout Pass Ski and Recreation Area verbenone project polygon stand condition summary from FINDITS stand information: polygon size (acres), average trees per acre (TPA), average lodgepole pine (LPP) TPA, stand basal area (BA), lodgepole pine BA, stand quadratic mean diameter (QMD), lodgepole pine QMD, and Randall Tensmeyer 2000 mountain pine beetle hazard rating.

Polygon (# plots)	Area (Acres)	Average TPA	LPP TPA (%)	Average BA	LPP BA (%)	Average QMD	LPP QMD	Hazard Rating
A&B (8)	10	283	163 (58%)	163	115 (71%)	10.6	11.7	Moderate
C (2)	1.2	151	140 (93%)	115	105 (91%)	12.5	12.2	Moderate
E (2)	2.5	152	50 (33%)	105	60 (57%)	11.6	15	Moderate
F (2)	1.3	385	63 (16%)	185	35 (19%)	9.4	10.7	Low
H (2)	0.8	134	54 (40%)	120	60 (50%)	12.8	14.1	Moderate
I&J (5)	5.5	151	47 (31%)	92	42 (46%)	10.9	12.9	Moderate
K (2)	1.1	247	247 (100%)	155	155 (100%)	11.1	11.1	Moderate
L (2)	2.5	370	370 (100%)	153	153 (100%)	8.9	8.9	High
M (10)	12.1	586	586 (100%)	215	215 (100%)	8.3	8.3	High
N&O (15)	14.4	231	231 (100%)	126	126 (100%)	11.0	11.0	Moderate
P (10)	9.6	243	149 (61%)	116	62 (53%)	9.8	9.8	Moderate
AA (3)	2.96	659	659 (100%)	210	210 (100%)	7.7	7.7	Moderate
BB (4)	4.69	538	538 (100%)	210	210 (100%)	8.6	8.6	High
CC (4)	4.25	489	489 (100%)	158	158 (100%)	8.2	8.2	High
DD (5)	5.96	563	557 (99%)	232	230 (99%)	8.7	8.8	High
EE (10)	25.03	598	558 (93%)	209	195 (93%)	8.4	8.4	High
FF (10)	11	335	305 (91%)	150	130 (87%)	9.8	9.5	High
Below Skiway (8)	10	333	320 (96%)	173	168 (97%)	10.1	10.3	High

RATE OF LOSS PREDICTION

A 10-year rate of loss prediction model developed by Cole and McGregor (1983) was run on survey information collected in the spring of 2009 from the forested strip polygons. Results are summarized in Table 4. Cameron *et al.* (1990) found that in areas where MPB populations became established, predictions of

mortality using the Cole-McGregor model were within 25% of the actual mortality observed.

In most of the forested strips between ski runs on the ski hill, continued MPB activity may result in more significant losses to the lodgepole pine component.

TABLE 4: Polygon size, Randall/ Tensmeyer (2000) mountain pine beetle hazard rating, and Cole-McGregor (1983) mountain pine beetle in lodgepole pine 10-year rate of loss prediction model (if beetle populations become established in a stand) results for leave strip polygons surveyed in spring 2009 on the Lookout Pass Ski and Recreation Area.

Polygon:	Acres:	Stand Hazard:	2008 Live LP Pine TPA*	Estimated 10-Yr Post Outbreak LP Pine TPA*	Estimated % LP Pine TPA* Lost
A&B	10.0	Moderate	125	35	72%
C	1.2	Moderate	124	45	64%
E	2.5	Moderate	50	6	88%
F	1.3	Low	63	45	29%
H	0.8	Moderate	49	6	88%
I&J	5.5	Moderate	2	1	50%
K	1.1	Moderate	159	38	76%
L	2.5	High	336	130	63%
M	12.1	High	426	105	75%
N-O	14.4	Moderate	101	45	55%
P	9.6	Moderate	91	81	11%
AA	2.96	Moderate	467	102	78%
BB	4.69	High	427	91	79%
CC	4.25	High	419	158	62%
DD	5.96	High	449	103	77%
EE	25.03	High	487	184	62%
FF	11	High	199	102	49%
Strip Below Skiway	10	High	171	62	64%

*TPA = Trees per Acre

SUMMARY OF BEETLE RELATED FINDINGS

The lodgepole pine trees and forests in and around Lookout Pass Ski and Recreation Area are currently susceptible to bark beetle attack. Many of the forested strips between ski runs on Lookout Pass are comprised primarily or exclusively of lodgepole pine (Table 3). They would be substantially altered if beetle populations became established and lived up to their potential for tree killing. Continued MPB losses on the ski hill could be prevented. Silvicultural treatments geared towards removing trees currently infested by bark beetles and reducing stand hazard to bark beetles by influencing the quantity, density, and/ or size of residual lodgepole pine trees are the best options to prevent additional losses at this time. Preventative insecticide sprays may also be useful to protect individual high value lodgepole pine trees. Planting non-susceptible species would also reduce stand hazard.

Aerial detection surveys and FINDITS surveys in untreated polygons show MPB continues to kill trees in and around the ski hill.

While the use of verbenone may have reduced MPB caused mortality from 2003-2008, MPB continued to kill trees in treated polygons. Verbenone is not effective in preventing attacks by other bark beetles such as IPS. IPS, often associated with logging activity and wind throw, has been active on the ski hill in recent years, though no current activity was documented during evaluations in the spring of 2009.

RECOMMENDATIONS

- Recent lodgepole pine mortality on the ski hill has been substantial. While direct suppression efforts may increase the longevity of lodgepole pine remaining in the short term, it would be prudent to consider what options are available to compensate for ongoing losses of this species. An evaluation of the current conditions and threats to the vegetative component of the Lookout Pass

- Ski and Recreation Area is a significant component of the recently completed Vegetation Management Plan for the ski hill. It will assist managers as they plan the future of the ski hill.
- Because of ongoing losses in the lodgepole pine of treated polygons and the high cost of applications, additional verbenone treatments will not be supported by Forest Health Protection prevention, suppression, and restoration project funds.
- Managers might want to consider individual tree protection using insecticidal sprays for certain high value trees or for all trees in important buffer strips to protect against MPB and IPS attack (verbenone alone is not effective against IPS). To be effective, insecticidal sprays would need to be applied with a high pressure device which may be difficult to maneuver on steep terrain. The cost of individual tree protection may be prohibitive over a large scale. Please contact FHP for current insecticide and application recommendations.
- Implementation of the recently completed vegetation management plan would be helpful as the District deals with the continued MPB activity in the Ski and Recreation Area. Prevention and restoration strategies should be considered rather than the current emphasis on verbenone based suppression strategies.

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APPENDIX 2: SUMMARY OF LOOKOUT PASS FOREST HEALTH PROTECTION SUPPRESSION FUNDING

Total FHP funding for verbenone treatments to protect lodgepole pine in forested areas between ski runs at Lookout Pass Ski and Recreation Area from 2003 through 2008 treatment.

Year	Pre treatment Surveys (Acres)	Treatment (Acres)	Post treatment Surveys (Acres)	Indirect Costs	Total Cost
2003	\$2000 (500)	\$8,800 (40)	\$200 (40)		\$11,000
2004	\$1,500	\$23,500 (100)	\$750 (100)	\$5,923 (23%)	\$31, 673
2005		\$30,400 (120)	\$750 (120)		\$31,150
2006	\$1,280 (20)	\$34,400 (129)	\$1,720 (129)	\$2,200	\$39,600
2007		\$22,500 (130)			\$22,500
2008		\$23,500 (130)	\$2,000 (130)		\$25,500
Total	\$4,780	\$143,100	\$5,420	\$8,123	\$161,423

APPENDIX 3: HAZARD RATING SYSTEM FOR MOUNTAIN PINE BEETLE IN LODGEPOLE PINE USING THE ORACLE DATABASE AND THE FOREST SERVICE IBM PLATFORM

Carol Bell Randall, Entomologist, R-1 Forest Health Protection
and
Greg Tensmeyer, Management Systems, Idaho Panhandle National Forests

Hazard Rating

Hazard is the ability of a stand to support a growing population of mountain pine beetles. It is defined by two factors--the quality and the quantity of susceptible lodgepole pine. The quality of the lodgepole component of a stand as a mountain pine beetle food source is best characterized by stand density and phloem thickness. Since lodgepole pine phloem thickness is not measured in stand exams, diameter at breast height (d.b.h.), age, and other available stand characteristics are used as surrogates. The quantity of the food source refers to the species composition and density of the forest. A pure, well stocked lodgepole stand will be more likely to support a large mountain pine beetle population than a mixed species and/or poorly stocked stand.

The location of a stand also has a bearing on mountain pine beetle success. Lodgepole pine growing in cold, high-elevation areas is less likely to generate outbreak levels of mountain pine beetles because the beetle takes longer to complete its life cycle.

Hazard Rating Criteria

This hazard rating system follows a step-wise progression to determine hazard. A stand "falls out" at the first statement that describes its condition. Logic of this step-wise progression follow:

Mountain Pine Beetle in Lodgepole Pine Hazard Rating Logic

- | | |
|---------------------------------------------------------|---------------------------------|
| 1. If % BA Lodgepole Pine = 0 | Then Hazard = 0 - Extremely Low |
| 2. If % BA Lodgepole Pine < 25% | Then Hazard = 1 - Low |
| 3. If Stand BA <80 or >250 | Then Hazard = 2 - Low |
| 4. If # Tree per Acre > 3" d.b.h. < 100 or > 800 | Then Hazard = 3 - Low |
| 5. If Average d.b.h. Lodgepole Pine > 5" d.b.h. is < 6" | Then Hazard = 4 - Low |
| 6. ¹ If Subcompartment = | Then Hazard = 4.5 - Low |
| 7. ² If stand age <60 | Then Hazard= 4.75 - Low |
| 8. If % BA Lodgepole Pine is 25-50% | Then Hazard = 5 - Moderate |
| 9. If Stand BA is 80-120 | Then Hazard = 6 - Moderate |
| 10. If # Trees per Acre > 3" d.b.h. 100-300 or 600-800 | Then Hazard = 7 - Moderate |
| 11. If Average d.b.h. Lodgepole Pine > 5" d.b.h. is <8" | Then Hazard = 8 - Moderate |
| 12. ¹ If Subcompartment = | Then Hazard = 9 - Moderate |
| 13. ² If stand age > or = 60 but <80 | Then Hazard = 9.5- Moderate |
| 12. Else | Then Hazard = 10 - High |

¹These clauses allow the incorporation of location into hazard calculation and require information from outside TSMRS. Elevation, Latitude, and Longitude are not included in TSMRS, but are available from other sources. The method to determine the location hazard factor can be found in Appendix 1.

²As programmed the mountain pine beetle hazard rating can be run with or without using age information.

